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FIELD OBSERVATIONS ON STRAWBERRY DWARF

By NEIL E. STEVENS, *Senior Pathologist, Division of Horticultural Crops and Diseases, Bureau of Plant Industry*

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INTRODUCTION

Although attention has been attracted to it by recent investigations, the dwarf disease of strawberries is by no means new to the United States. It was established in Florida, Louisiana, and the Carolinas at least 15 years ago, and there is reason to believe that it has been present in Florida for 40 years. As early as 1915 certain cultural practices that tend to keep this disease in check had been developed in Florida. These will be discussed later.

What is known of the history and distribution of this disease is presented in the present circular, together with such information as may be of practical value to pathologists, nurserymen, strawberry growers, and others. In addition to the published papers cited, the writer has made use of unpublished observations by E. A. Bessey, R. B. Wilcox, G. Steiner, B. G. Chitwood, and P. V. Mook. The writer, however, is solely responsible for the conclusions and recommendations in this circular.

Many common names have been applied to this disease of strawberries in various parts of the South. Among those actually found in use by the growers in Florida or Louisiana are dwarf, crimp, crimps, French bud, white bud, brier bud, possum ears, frenching, curly leaf, male plant, and wild plant. The name dwarf is used in this circular because it has come into general use among growers in Louisiana and North Carolina and was used in connection with the first description of the disease (8).¹

DESCRIPTION

Figure 1 gives an excellent idea of the appearance of a severely diseased plant. The most conspicuous symptom of the disease, the one from which all its common names are derived, is the malformation it induces in the young leaves as they develop. The leaves of diseased plants become reduced in size and much deformed. The

¹ Italic numbers in parentheses refer to Literature Cited, p. 7.

edges of the leaflets are crinkled. In extreme cases the entire plant is dwarfed, and the internodes of the runners are shortened. In Florida even the flowers may become distorted, and the fruit when it matures is misshapen. The symptoms are most conspicuous during the summer months; in fact, in North Carolina the symptoms of the dwarf disease can be readily recognized only in the summer months. In Florida, however, some diseased plants can usually be recognized at any time of the year.



FIGURE 1.—Typical "dwarf" strawberry plant of the Klondike variety. (Photographed by P. V. Mook at Chadbourn, N. C., August, 1928)

In all the regions where the disease has been observed, the root systems of dwarf plants are as well developed and apparently as healthy as are those of normal plants growing under the same conditions.

Runner plants from diseased mother plants usually, though not always, show the disease. The commonest method of introducing

dwarf into new fields is by planting diseased plants. Field observations indicate that the disease is spread by water, especially when a slightly infected field is flooded (10).

EARLY FIELD OBSERVATIONS

The earliest observations on strawberry dwarf in this country of which we have knowledge were made by Ernst A. Bessey during the period from 1901 to 1906. He examined specimens of this disease brought by A. N. Brooks from Florida in December, 1930, and stated in a letter to the writer that it is "clearly the same disease that I first studied about 1901 and later more extensively about 1905 and 1906." Bessey further states that the disease was very severe on strawberries in Spartanburg, S. C. about 1905.

In the Yearbook of the United States Department of Agriculture for 1905 (7, p. 606) the following statement appears: "*Strawberry*.—A bud nematode was found to be injurious in one instance in South Carolina." This obviously refers to Bessey's observations, as the Plant Disease Survey card on which the published statement was based bears the note that "Dr. E. A. Bessey visited the place" and found "*Aphelenchus* in crown and bud" of strawberries. This brief statement in the Yearbook is the earliest published reference to the dwarf disease of strawberries in the United States that the writer has found.

Bessey's unpublished notes, a copy of which he has generously sent the writer in a letter dated February 12, 1931, include a careful description of the nematode which he found in the buds of the diseased strawberry plants and the following notes on its occurrence:

December 12, 1905. Spartanburg, S. C. About one acre in strawberries, mostly Lady Thompson. Field is sloping except about $\frac{1}{2}$ or $\frac{1}{4}$ acre which is perfectly flat. On this part the disease (*Aphelenchus*) is worst. Disease very abundant on this part, here and there on other parts.

During February and March, 1915, 1916, 1917, and 1918, R. B. Wilcox, who was at that time studying the fruit rots of strawberries in Florida and Louisiana, made a number of observations on the dwarf disease. Some of his notes are of interest in relation to the distribution of the disease at that period and the length of time it has been present in the Southern States. It was the opinion of the older growers interviewed by Wilcox at Stark and Lakeland, Fla., in 1915, that the disease had been present in northern Florida at least 27 years before that date and as long as strawberries had been grown in the other parts of the State. It was also their opinion that the disease was always found to some extent in home-grown plants. Opinions differed as to whether northern-grown plants ever showed the disease the first year, but it was agreed that plants from the North showed less of the disease than those locally grown. At that time Illinois was an important source of plants. It was generally believed that the relative freedom of northern-grown plants from this disease was one of the chief reasons for buying new plants each year from the Northern States. A fairly general practice among Florida growers in 1915 was to discard diseased plants when the plants were removed from the beds for setting in the field. At that time, as at present,

in Florida, the strawberry plants for the main fruiting plantations were set out in September or October, which is a very favorable period for recognizing the plants affected with the dwarf disease.

During part of the time Wilcox was in the field in the years 1915 to 1918, G. M. Darrow was frequently with him. Many of Wilcox's observations were made in company with Darrow, who included the substance of these observations in a bulletin issued in 1919 (5, p. 13). In this bulletin appears the following statement regarding the distribution and control of this disease:

Experienced growers are able to recognize the "crimps" [dwarf] in their propagating beds and discard them. As the only means of control is prevention by using healthy plants, all suspicious plants should be discarded when setting is being done. This disease is common in Florida, Louisiana, southern Mississippi, and North Carolina, and has been found in the Norfolk (Va.) district.

The earliest published illustration of the dwarf disease in this country is that of Plakidas (8), who worked in Louisiana. Plakidas states that the disease has been recognized by growers in Louisiana for a number of years, and writes (8, p. 441) regarding the cultural practices of growers in that section as follows:

In fields in which the growers have recognized the disease and practiced systematic roguing, relatively few dwarfed plants are found. Incidentally, it may be stated here that those growers who are keen and careful enough to rogue and select their plants are the most successful in this section. In fields where little or no roguing has been practiced, 10 or 20 per cent of the plants may be found dwarfed. It is the unanimous opinion of all growers interviewed that dwarfed plants are practically worthless, for they produce very little fruit or none at all, and what is produced is of small size and has practically no market value.

In 1929, Brooks, Watson, and Mowry (4) described the disease and called attention to the presence of nematodes in diseased plants. Later Brooks (3) presented the results of inoculation experiments in which the disease was produced "by introducing suspensions of the nemas into buds of healthy plants."

CAUSE

The careful studies by G. Steiner and his associates on the nematodes of the strawberry are being prepared for publication elsewhere. It is sufficient for present purposes to state that Steiner considers the nema associated with strawberry dwarf as identical with, or closely related to, *Aphelenchus fragariae* Ritzema-Bos, which is believed to cause the "cauliflower" disease of strawberries in Europe. This nema was discovered on strawberries in England in 1890 (2), 11 years before Bessey observed the disease in this country. If the strawberry-bud nema of Europe is indeed identical with that in the United States, it seems probable that it may have been introduced into this country many years ago, as importations of strawberry plants from Europe have been frequent. As the Klondike variety was originated in Louisiana in 1901 (6), and European strawberries were grown in Louisiana prior to its introduction, this variety may well have been infected from its inception and have carried the disease into whatever regions it was shipped to.

IMPORTANCE

Estimates of the losses due to the strawberry dwarf disease vary widely. In this connection Brooks, Watson, and Mowry (4, p. 500-501) say:

The loss of plants due to crimps is 0 to 75 per cent in individual fields and about 2 per cent for the entire State [Florida]. * * * Crimped plants are worthless as fruit producers, because what fruit they do put on is late and of inferior quality. The severity of the disease may result in the killing of the main bud, with the subsequent death of the plant, unless lateral buds chance to develop. * * *

In his later paper Brooks (3) points out that the disease is apparently "more destructive in Florida than elsewhere."

Plakidas has recently sent the writer the following unpublished report of actual field tests of the yield of healthy and dwarfed plants carried out at Hammond, La., in 1930:

Healthy plants yielded 10.7 per cent more per plant than the dwarfed ones. However, since the dwarf plants give a poorer stand than the healthy ones, if we take into consideration the number of dwarfed plants dying off, the yield per acre is about 22 per cent better for the healthy ones. These figures will not apply to the field-run plants. The average percentage of dwarfed plants in a field is about 10 per cent for the whole strawberry-growing section. So the decrease in yield due to dwarf for the average field is about 1 to 2 per cent.

The observations of Mook and others in North Carolina indicate that the disease is not as important there as in Louisiana and Florida, for apparently in this region diseased plants often bear good crops. This characteristic will be discussed below.

A series of observations carried out by B. G. Chitwood during the summer of 1930 in a field near Chadbourn, N. C., indicated a death rate from all causes among dwarf plants from three to four times as great as that among apparently normal plants.

About all that can safely be said of the importance of dwarf is that it has for many years constituted a drain upon the strawberry industry of the South; but where careful avoidance of infected plants for planting is practiced, the disease has nowhere yet been of such decisive importance as to interfere seriously with the production of a district.

Within the area where dwarf has been known at least 10 years, there is a progressive decrease in its importance from the south northward. The disease is most severe in Florida, less severe in Louisiana, and still less so in North Carolina. Although it existed near Norfolk, Va., in 1918 or earlier, a brief survey in 1930 failed to reveal its presence on any commercial plantation in this region. The foregoing observations all apply to the behavior of the disease on the two standard commercial varieties commonly grown in the South, Klondike and Missionary, and furnish little indication of its behavior on untried varieties.

ASSOCIATION WITH OTHER DISEASES

One fact which makes difficult an accurate estimate of the losses due to dwarf is that this disease is often associated with other diseases and pests. That portion of the United States in which

dwarf has been longest known is also the region in which the root-knot nema is most severe. Apparently various root fungi are also factors in strawberry culture in these States, but their relative importance is unknown, as a serious study of them has only recently been begun. The same is true of the strawberry root aphid, *Aphis forbesi*.

The same confusion as to the relative importance of the various strawberry diseases exists in Great Britain. While the so-called Lanarkshire (1) disease in Scotland is now generally conceded to be a root disease due apparently to a species of *Phytophthora*, no general agreement has been reached among workers as to the relative importance of the various strawberry diseases and pests in England. English investigators, however, generally agree that the injury due to the "cauliflower" disease, at least in its typical form, is minor as compared with that caused by "red plant" (now generally believed to be distinct from "cauliflower") and to the injuries caused by aphids and mites.

SEASONAL BEHAVIOR OF DISEASED PLANTS

One of the earliest observations regarding the dwarf disease in Florida was that it appeared to be less severe in cold weather. In North Carolina the spring foliage of diseased plants does not appear to have any of the characteristic symptoms, yet as the warmer months approach the symptoms always return. During the fruiting season dwarf plants in this region have thus far not been distinguishable from normal ones. Dwarf Klondike plants marked at Chadbourn, N. C., during September or October, 1926, 1927, and 1928, were indistinguishable from normal plants the succeeding spring. In the spring of 1930, however, between April 21 and May 17, Chitwood found *Aphelenchus fragariae* in small numbers on the buds of plants apparently healthy but known to be diseased the previous year. By June 12 the number of *A. fragariae* had increased to an average of 75 per bud.

The unpublished observations of Plakidas in Louisiana during 1929 and 1930, and of Mook in North Carolina in 1929, suggest that when a lot of strawberry plants containing some dwarf plants is set in the field under adverse conditions—that is, in very hot or dry weather—a larger number of the dwarf plants than of the healthy ones are killed; also that in the case of extreme heat or freezing injury, the dwarf plants are killed in larger numbers than the healthy ones.

DISTRIBUTION OF DWARF

Recent studies have added little to the known range of the dwarf disease beyond that indicated by Darrow in 1919. The disease is abundant in strawberry-growing areas of Florida, Louisiana, and North Carolina. A survey conducted during the summer of 1930 along the northern limits of the known distribution of the disease resulted in finding dwarf in western Tennessee and northern Arkansas in commercial plantings of standard varieties of strawberries. It was found in Kentucky, Maryland, Delaware, and eastern Virginia on plants brought into the region in the spring of 1930, or in

experimental plantings. Strawberry-growing areas were visited, but no dwarf was found in southeastern Tennessee, southwestern Missouri, southern Illinois, western Kentucky, southern Indiana, and southwestern Ohio. While the disease very probably is present in some of these last-named localities, the assertion may safely be made that it was not serious in 1930. Dwarf has been found in the United States on Missionary, Klondike, Premier, Heflin, and Blakemore varieties.

CONTROL METHODS

The control methods already practiced, often unconsciously, in the South—roguing, planting on new land where possible, and procuring plants from regions where the disease is not common—have served to keep dwarf in check in that region. There is no reason to believe that the disease is more serious in North Carolina now than it was in 1926, or more serious in Florida than it was in 1915.

Roguing, where practiced experimentally under the writer's observation, was not proved to be of value if carried out as a special operation; but the routine removal of diseased plants, when hoeing, costs little and is probably worth while.

Studies by Steiner (9) have proved that the hot-water treatment (118° F. for half an hour) will free diseased plants of the nematode. Treated plants, however, require special care for a limited period, and this method is probably not practicable on a large scale.

Crop rotation is recognized as one of the most practical methods of controlling the root-knot nematode (9) and may well prove effective against the bud nematode.

On the basis of present information one of the most promising lines of attack for increased control of the disease is systematic nursery inspection within the area where the disease occurs, and certification of disease-free plantings. As already explained, since the disease can not be detected with any degree of certainty except during hot weather, this would necessitate inspection for the presence of the disease during the previous summer.

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